

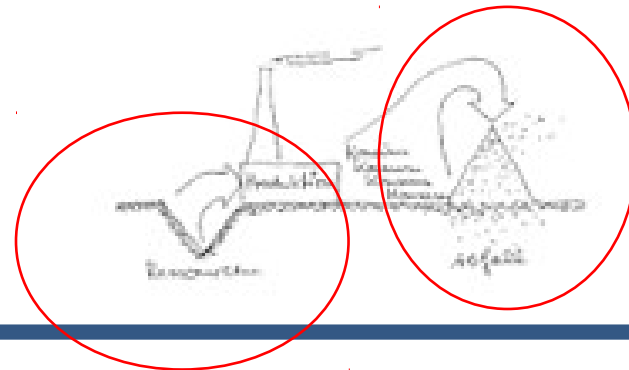


# Open Cycles at Different Scales

... of plant nutrients ...

Martin Kaupenjohann

# Current situation



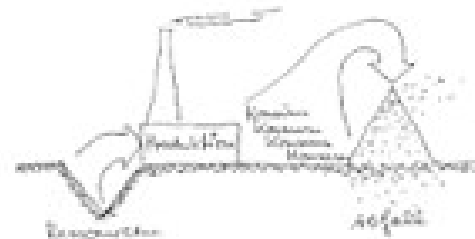
# Current situation



Surface mine in Garzweiler, Germany  
(*pressebox.de* 2013)



Waste hills in the ocean - as large as  
Texas (*greenaction.de* 2013)

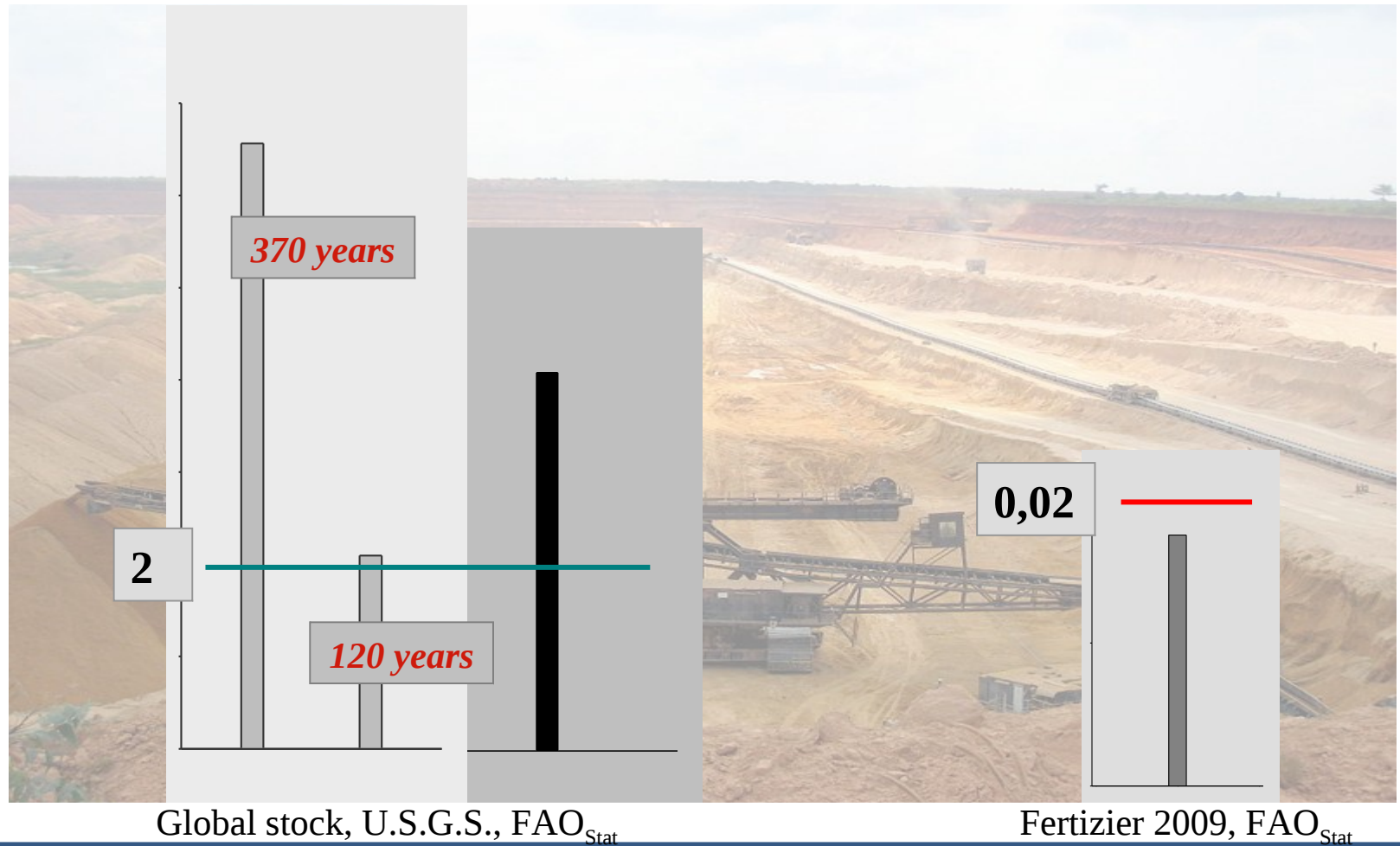


## *Phosphorous*



Togo, Phosphate mine

## Phosphorous ( $10^9$ t)



Reserves Resources *ar. Soils*



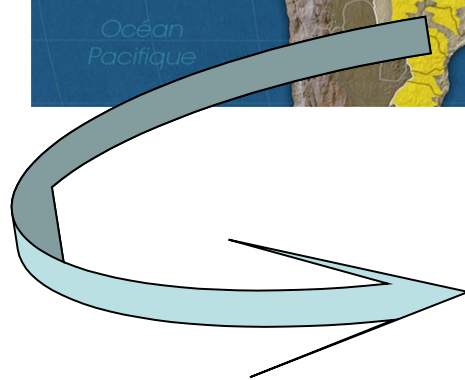
## *Soybean trade*



Soybean field in Argentina, *F. Kopp*, 2013

# Continental Scale

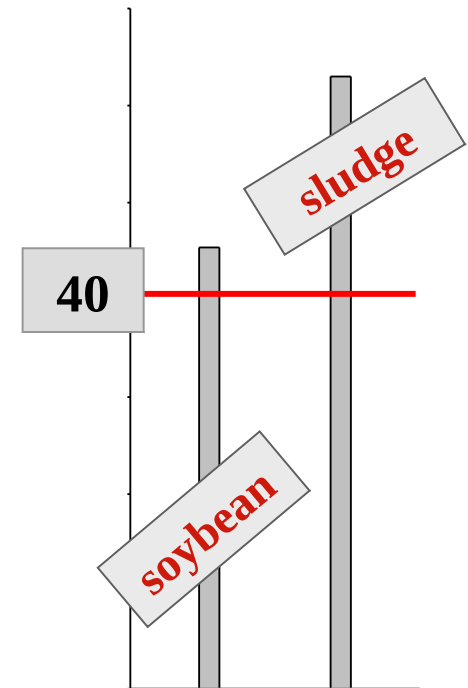
## Soybean trade



Total **6.484.989 t** in  
2009, about 1/3 from  
Brazil, FAO<sub>Stat</sub>



$10^3 \text{ t P}$  (2009)



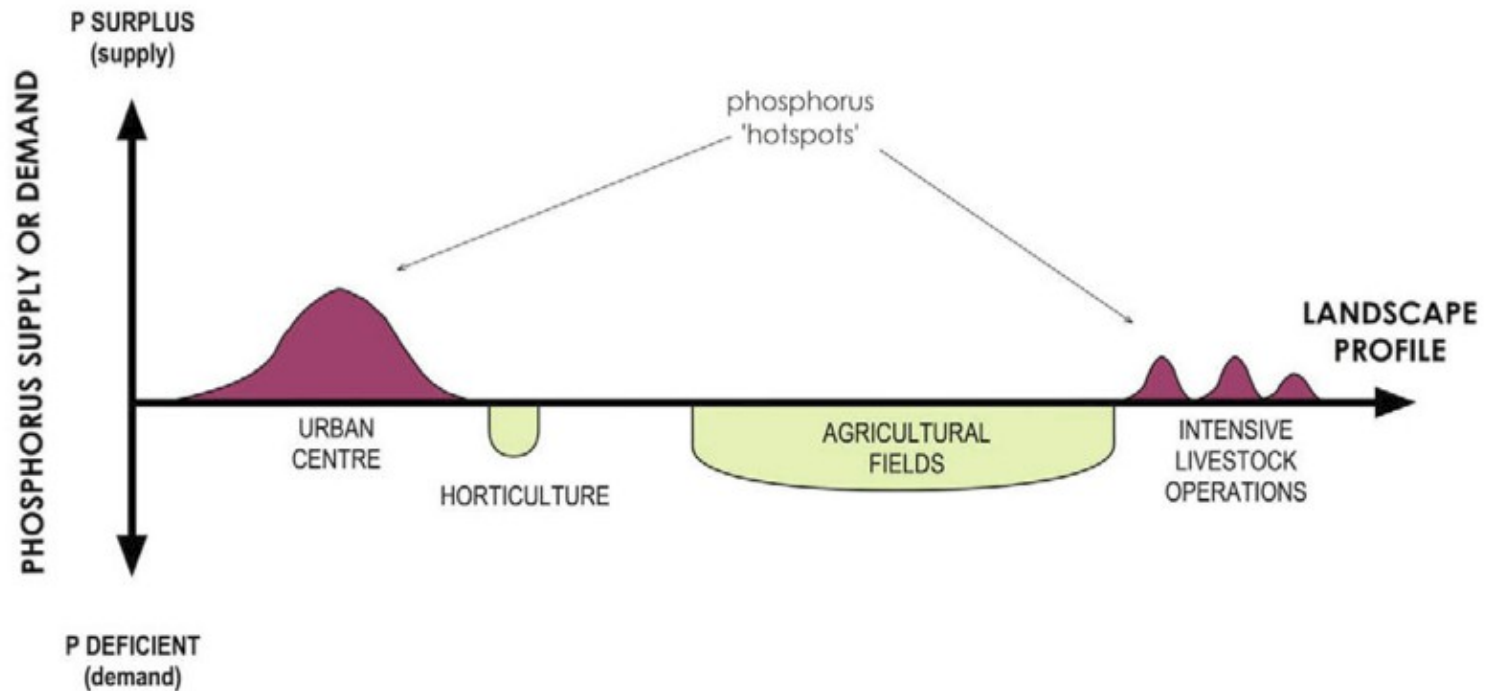
# Continental Scale

Germany's soybean import in overseas  
accounts for more than 1/3 of the P demand  
of the whole European population

... no recycling back to  
overseas...

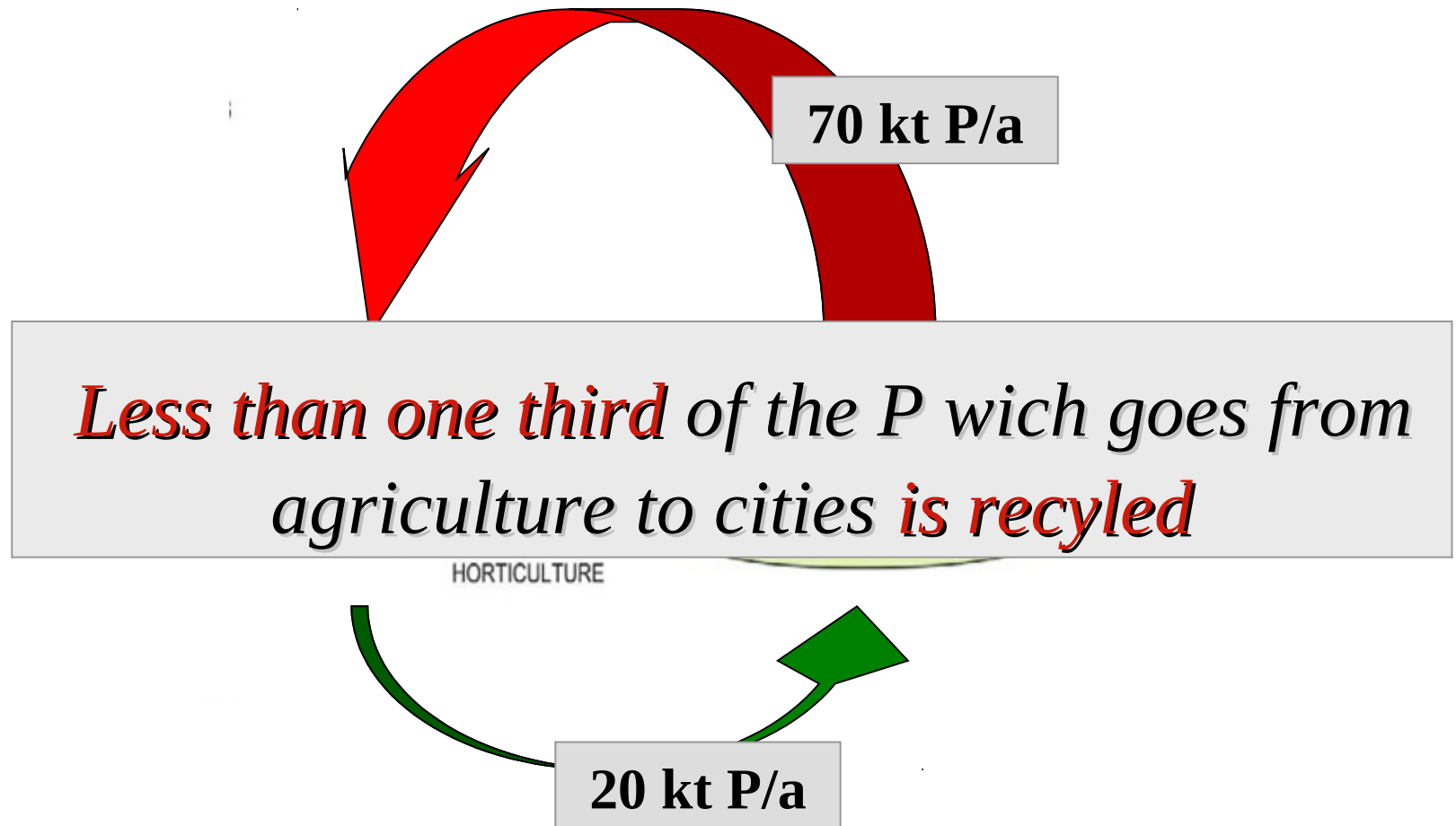


# Regional Scale



**Figure 5-11:** Spatial profile of an urban-rural landscape – indicating that while agricultural and horticultural fields demand continual phosphorus fertilizers, cities are ‘phosphorus hotspots’ of food waste and human excreta that could be productively utilized to meet some of the fertilizer demand. The phosphorus in the ‘hotspots’ originated from local or distant agricultural fields, hence returning the phosphorus to these sources would be closing the loop to an extent. Source: created for this research.

# Regional Scale

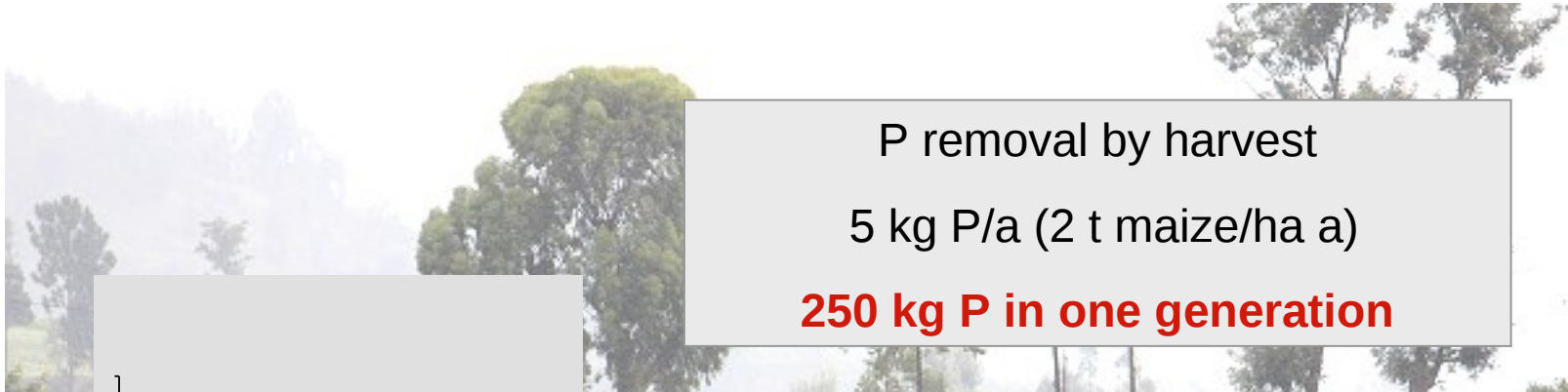


# *Local Scale*



*Rwanda*, swissinfo.ch 2013

# Local Scale



Soils lose 10 to 30% of the total P stock within only one to two generations of „open-cycle“ small-scale agriculture



*P (kg/ha) stock in tropical soils,*

Nitsch, 2013



„His“



# PERMANENT AGRICULTURE IN CHINA, KOREA AND JAPAN

F. H. KING, D. SC., 1911

Sustainability is mainly based on closed  
nutrient cycles through use of „night soil“



India Res. Center, 2003

# „History“

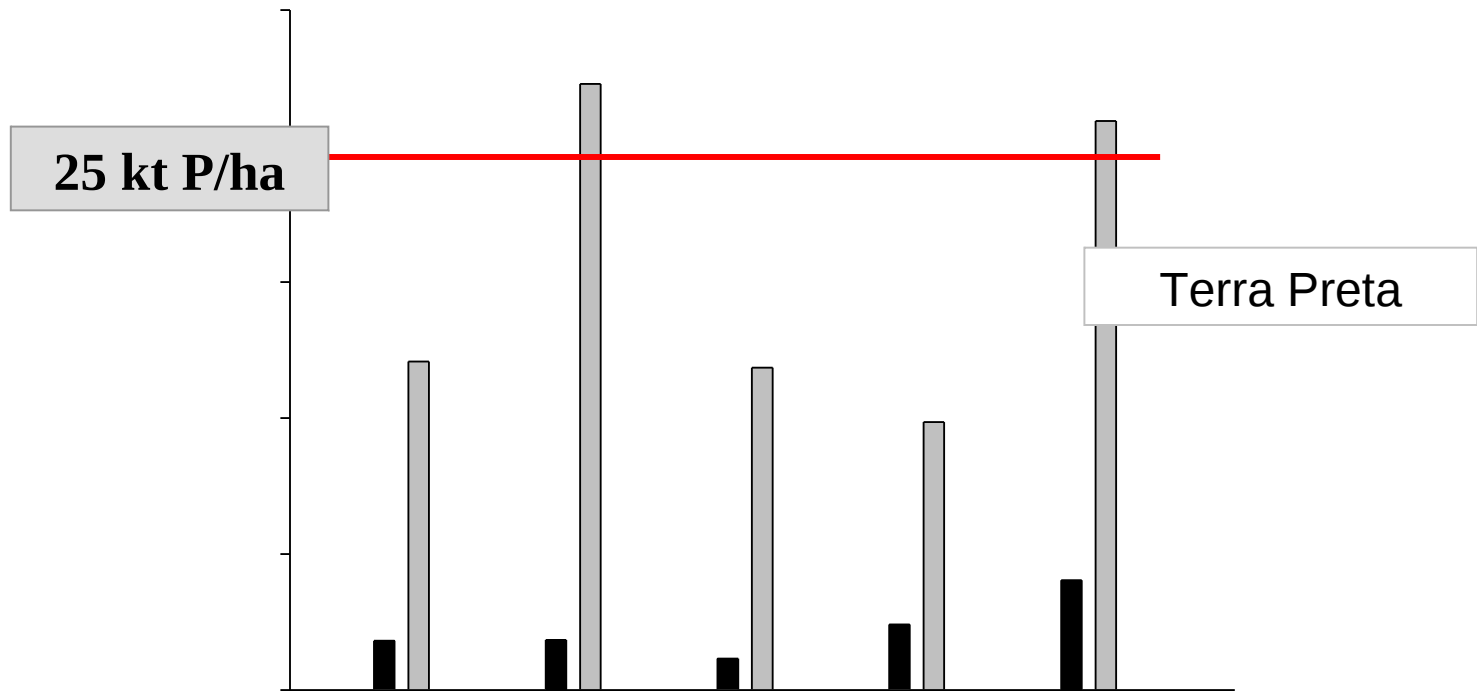


*Natural tropical soils, and **Terra Preta** do Indio*

B. Glaser



# „History“



*P stock in Terra Preta and natural tropical soils,*

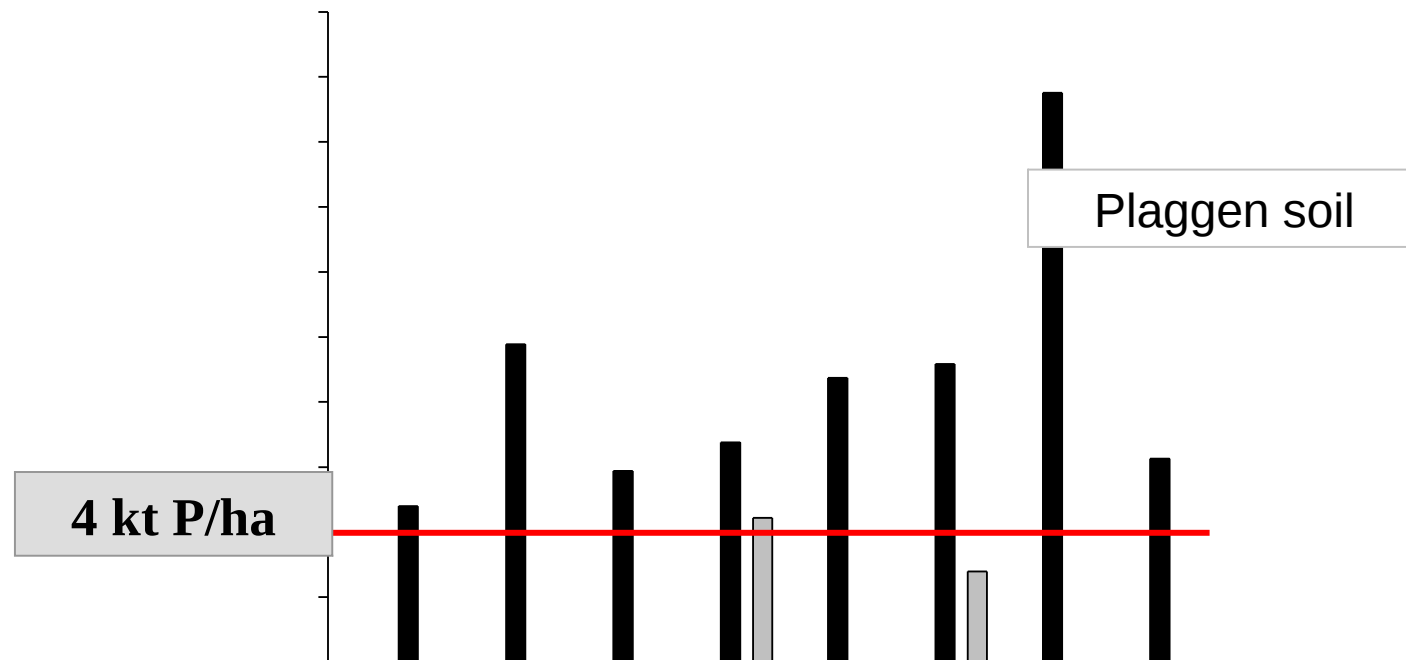
Nitsch, 2013

# „History“



*Plaggen-management started in the early middle ages and endet in the 20th century, DBG 2013*

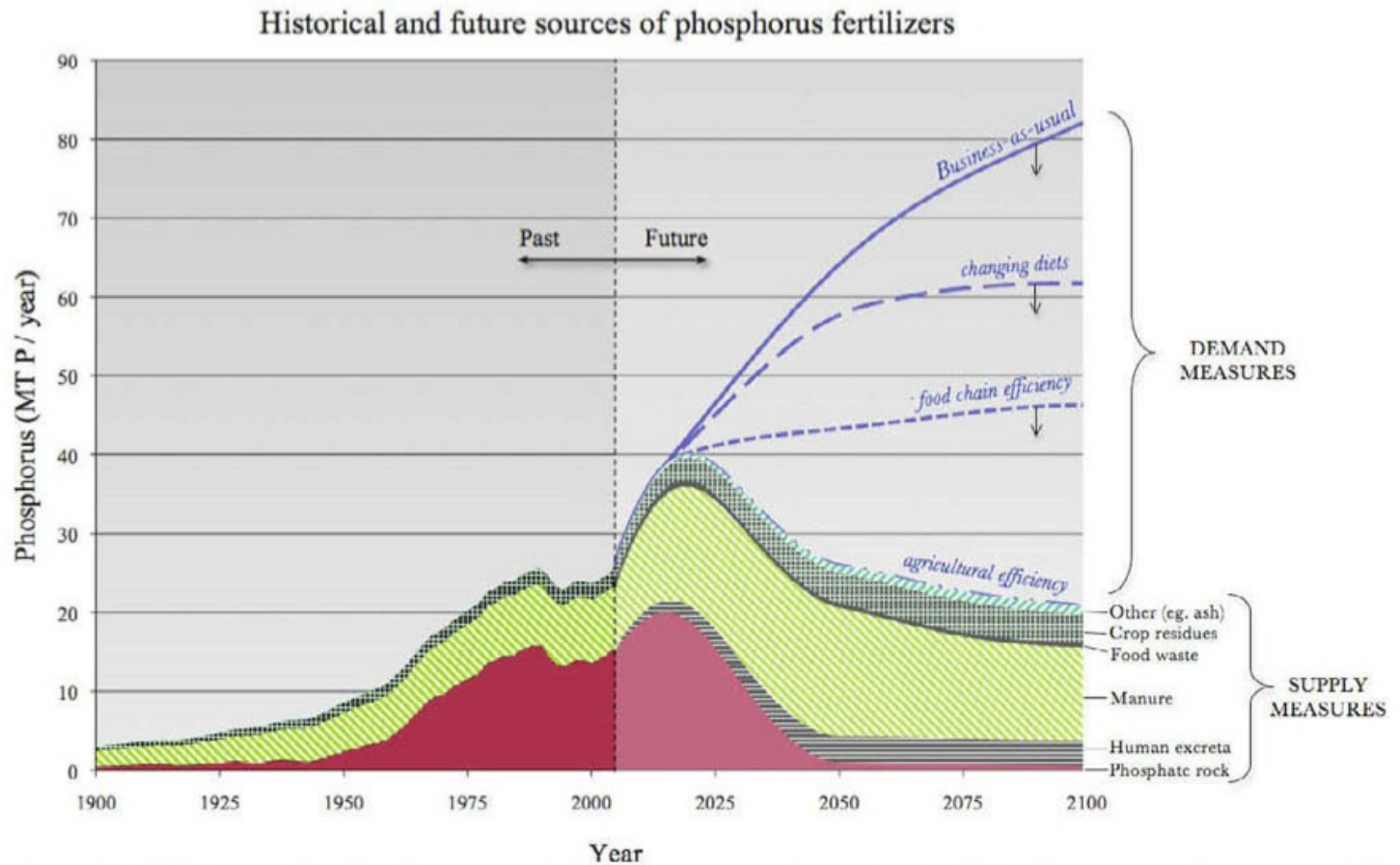
# „History“



*P stock in Plaggen soils and comparable natural soils,*

Nitsch, 2013

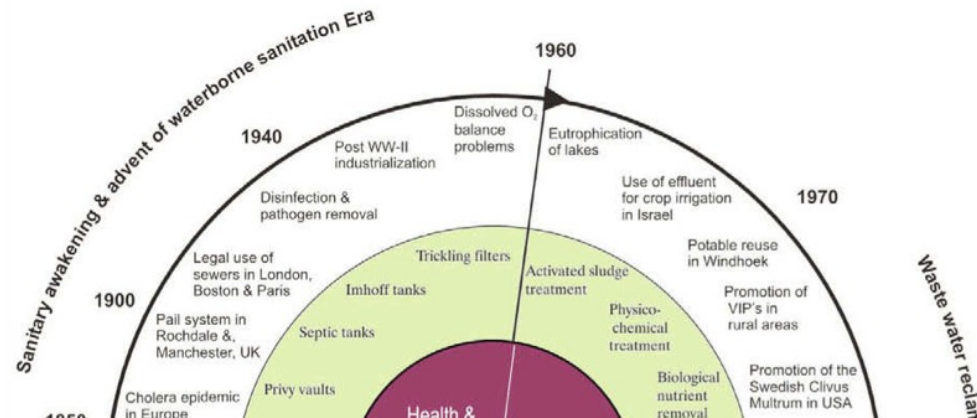
# History to future



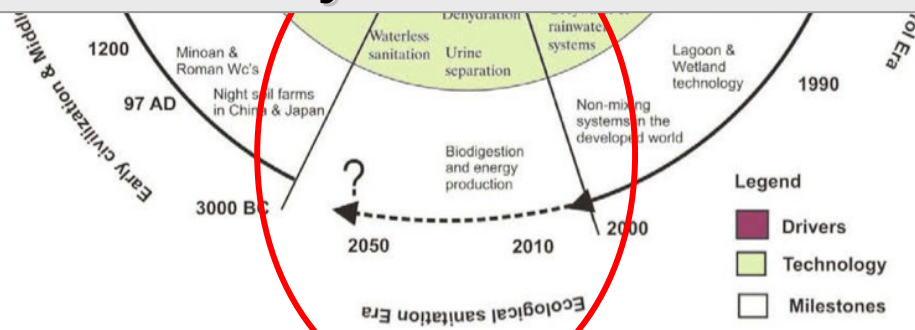
**Figure 6-3:** Meeting future phosphorus security through a range of demand and supply-side measures. Source: created for this research (Paper IV).

Cordell 2010

# Future?



Develop appropriate techniques to close the P-cycles at all scales



Cordell 2010

**Figure 5-13:** Evolution of sanitation throughout human history, from 'Early civilisation and the middle ages Era', to the 'sanitary awakening and advent of waterborne sanitation era', through to the 'waste water reclamation and eutrophication control Era', and possible future 'Ecological sanitation Era'. Source: Redrawn from figure 10 in Gumbo (2005).



Thank

You!